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ON THE INFLUENCE OF THE TIME OF SOWING UPON THE CROP YIELD OF SPRING CEREALS

YRJÖ PESSI
FROST RESEARCH STATION, PELSONSUO

Selostus:
Kevätviljojen kylvöajan vaikutuksesta satoon

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I. Introduction

The growing season in comparatively short in Finland. Moreover its length is considerably different in different parts of the country. If the growing season is considered as beginning at the time when the daily mean temperature exceeds +5°C and as terminating when this mean temperature drops below +5°C, it begins in South-Finland on 1—10. V, on the line through Kolari, Ranua, Suomussalmi on 15. V, and at the northern frontier on 1. VI, terminating on 10—25. X, 25. IX and 15—20. IX respectively. The length of the growing season is thus found to equal slightly more than 160 days in the southern parts of the country, 133 days on the line Kolari —Ranua—Suomussalmi, and about 110 days at the northern frontier of Finland. Since the average growing period of the latest varieties of spring wheat and oats is slightly more than 100 days and that of the earliest barley varieties slightly over 70 days, the length of the growing season as estimated in this way hardly imposes any limitations upon the cultivation of spring cereals, even in regions comparatively far in the north. However, several deviations from the average normal conditions result in the time favourable for the development of the plants being too short after all. The major cause of this is the relatively frequent occurrence of night frost in the latter part of the summer. On the other hand, there is a remarkable number of cultivated bog areas where the growing period of cereals is found to be longer than normal.

One of the measures which can be employed in order to avoid the detrimental influence of the above-mentioned circumstances is the cultivation of early species and varieties of cereals. However, even this is not always sufficient, particularly in the case of the actual cultivated bog areas. As it is impossible to postpone the termination of the growing season and since the temporary frost-prevention measure which can be primarily considered for cultivated fields, the use of artificial fog, is not efficient enough (Pessi 1956), attempts have to be directed towards the best possible utilization of the early part of the growing season. Among other things, this implies that the spring cereals should be sown as early as possible, as long as this is not done at the expense of crop yield and quality.

The prevailing custom in practice with regard to the sequence followed

in sowing the spring cereals is to sow the oats first, then the spring wheat, and the barley last. The work is done in this order because the two first-mentioned cereal plants have the longest growing period. However, the sowing of barley is also often postponed, because it is feared that this crop might suffer from the low soil temperature or be permanently injured by the night frosts in the spring. Against this stands the opinion of SAULI (1947) that early sowing is of advantage to the development of barley, for which reason this cereal should be sown immediately after oats and spring wheat.

At the research station of the Association for Bog Cultivation at Leteensuo (Lat. 61.1°N), experiments relating to the time of sowing have been made in a bog area (VESIKIVI 1937). The tests have shown that under these conditions an early time of sowing has without exception been most advantageous in the case of oats, and that barley as well should be sown fairly early. The hectolitre and 1 000-grain weights were highest in the crops which had been sown early. Similar results have also been obtained at the Plant Cultivation Research Station of northern Ostrobothnia (Lat. 64.8°N, ANTTINEN 1954), where the spring wheat and barley experiments were made in sandy soil and the oats tests in a sedge peat bog area. The quality of the crops was also best with the earliest time of sowing.

The sowing time experiments performed with oats in a bog area in Flahult, Sweden, show, according to the results of 9 years' experiments (OSVALD 1937, p. 335), that the quality and quantity of the grain yield was directly dependent on the time of sowing, being higher and better the earlier the seeds were sown.

According to 13 years' tests at Maesremyren, Norway, the first sowing of oats in a bog area gave the highest grain yield (HAGERUP 1938). In the case of barley, the two earliest times of sowing resulted, on an average, in a grain yield of the same magnitude, while the third sowing already produced an inferior yield.

In the following, a study will be made of the significance of the time of sowing of the spring cereals in conditions such as prevail at the Frost Research Station at Pelsonsuo ($\varphi = 26.5°$E, $\lambda = 64.3°$N), and an attempt will be made to analyze the factors involved in this question.

II. The experiments relating to the time of sowing

1. *Experimental procedure*

With the exception of one test, the experiments (from the years 1951 to 1955) were carried out in a cultivated bog area with a peat layer consisting of sedge peat. In 1951 and 1952 the test areas were located in an older cultivated area with a fairly well humified cultivated layer. In 1953 the tests were established on newly reclaimed peat land, and this same field section was retained as a site for the tests even in the subsequent years. With the exception of one test, all the field strips concerned in the sowing time experiments were admixed with sand in an amount of approximately 300 m^3 per hectare in connection with the reclaiming operations. The acidity of the soil varied between pH 4.8—5.3.

The test areas were annually given a fertilizer mixture consisting of 300—400 kg purified phosphate containing copper, 200 kg K50, and 65—100 kg Nos per hectare. The admixed fertilizers were spread by hand.

Autumn ploughing was always performed on the test areas. The spring tilling was done with a tractor-drawn disk harrow, usually twice. The fertilizers were applied between the two harrowing operations. No rolling was done.

The size of the test plots varied between 15 and 35 m^2, according to the width of the field strip and the working methods. In 1953, plots of 100 m^2 were used in one test. The number of replicates varied between 4—6. The sowing was done in 1951 with a Pl. Junior, and in the other years with an Isaria seeding machine with seven shares. The distance between the rows was 12.5 cm. The quantities of germinating seed used per hectare were as follows: In 1951—1953, 180 kg of oats and 160 kg of barley; in 1954—1955, 140 and 120 kg respectively. The test plots were situated in a row across the strip of field between two ditches.

The crop was cut with the sickle in 1951, with the scythe in 1952, and in 1953—1955 cutting was done using a midget tractor provided with a collecting stage attached to its cutting device of 140 cm width. The grain was bound up into sheaves and dried on poles.

In 1951—1953 the grain crop from the test plots was allowed to attain a moisture content corresponding to the humidity of the air in the storage

room. In 1954—1955, dry matter determinations were made of the grain samples and the grain yield was calculated as corresponding to 15 % moisture content. The straw yield is given on an air-dried basis.

The arrangement of experiments relating to the time of sowing has a drawback which is difficult to eliminate. In order that all test members might be mutually comparable in regard to their treatment, it is necessary to provide for a period of time of equal length between tilling and seeding in the case of each test member, but this presents great difficulties, particularly on the strips of field drained by open ditches. For this reason the entire test area in these experiments, except in the case of one test, was harrowed all at the same time in the spring. This may have had some influence upon the crop yields, primarily because in the case of the areas seeded at a later time it is possible that the moisture conditions did not always develop in the same way as they might do in practice. This point will be discussed in more detail later on.

2. *Results of experiments*

Experiments relating to the time of sowing of spring cereal have been carried out at the Frost Research Station at Pelsonsuo (Lat. 64.3°N) since the first summer of research activity, 1951. In these tests the first seeding was always done as early as possible. The results of the experiments are seen from Tables 1—3 and from Figs. 1 and 2.

Without exception, the results from the tests with *oats* follow the same course in all the years under consideration. The earlier the seeding was done, the higher was the grain yield. Similarly the grain weight was highest and the husk percentage lowest for the crops resulting from the earliest seeding (Table 4). With the exception of one test year the strength of the stalk was always better in the crops seeded at an earlier date.

From the tests with *barley*, results were obtained from all years except 1954, when the acidity of the soil prevented the growth of barley. The test results were not as consistent as those from the oats tests. It can be observed that the best grain yield was obtained from crops seeded about June 2nd, although the differences in yield in comparison with the other times of seeding were fairly small and no significant differences from the results produced by earlier seeding can be established by means of statistical calculation. It is also observable that, as a rule, earlier seeding did not result in lower yields than those from the latest dates of seeding. It is readily seen that in summers with frequent occurrence of night frost, early seeding gives the highest grain yield in the case of barley also (v. Fig. 2, curve 2), as was the case in 1952, for instance.

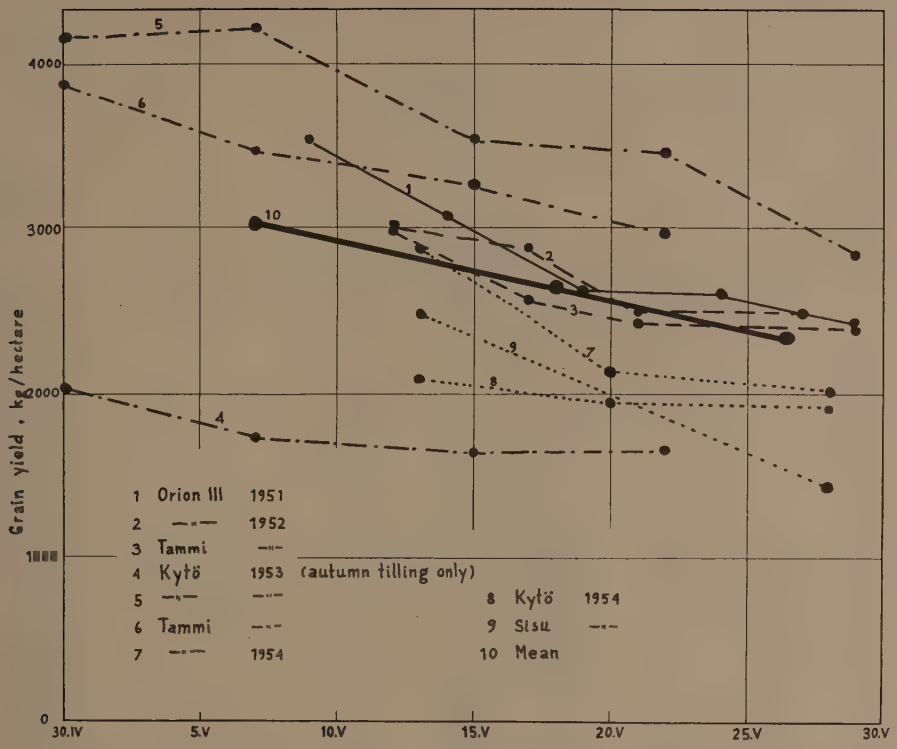


Fig. 1. The influence of the time of seeding upon the grain yield of oats.

Tests with *spring wheat* were performed at the Frost Research Station in 1951 only. The results of this test are seen from Table 2. Without exception, the earlier the seeding was done, the higher was the grain yield.

The values of the straw/grain yield ratio in Tables 1 and 2 show that in the case of oats and spring wheat the time of sowing had a different influence upon the grain yield than upon the straw yield, whereas no such effect was observed with barley, except in 1951.

In crops seeded at an early date the strength of the stalk was frequently better than in those resulting from later seeding (Tables 1 and 3). One of the factors which brings about this effect is probably the variation of the length of the stalk with the different times of sowing. Visual observations have shown that every year the stalk straw was shortest in the crops from the earliest seedings and its length increased with the postponement of the sowing. In 1955 measurements of the stalk length were made in connection with the barley seeding test, which consisted of only two test members

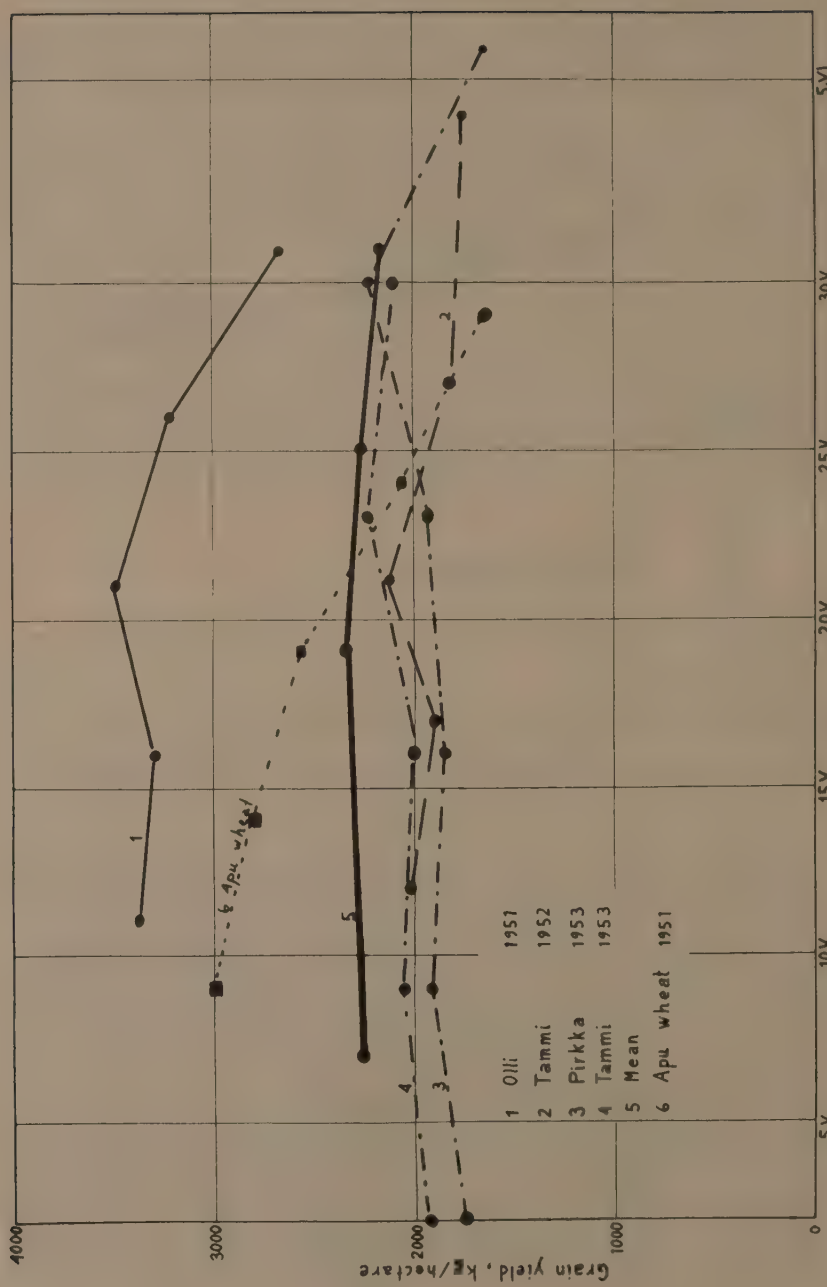


Fig. 2. The influence of the time of seeding upon the grain yield of barley and of Apu wheat.

Table 1. The results of the experiments relating to the time of seeding, performed with oats

Variety and time of seeding		Grain yield per hectare, kg	Grain yield per hectare, relative	Straw/grain yield ratio	1 000-grain weight, g	Growing time, days	Strength of stalk	Sprouting	Appearance of panicles
Orion III	9. V. 1951	3 530	100	1.8	—	119	10	4. VI	20. VII
	14. V. »	3 060	87	2.2	—	117	10	7. VI	22. VII
	19. V. »	2 630	75	2.5	—	116	9.5	10. VI	25. VII
	25. V. »	2 610	74	2.6	—	111	9.5	12. VI	27. VII
	29. V. »	2 420	69	2.8	—	106	9.2	13. VI	28. VII
Orion III	12. V. 1952	3 000	100		30.5	124	70	2. VI	20. VII
	17. V. »	2 880	96		29.9	119	10	5. VI	21. VII
	21. V. »	2 500	83		28.3	115	10	7. VI	22. VII
	27. V. »	2 490	83		26.9	109	10	9. VI	26. VII
Tammi	12. V. 1952	2 980	100		27.9	124	10	2. VI	20. VII
	17. V. »	2 580	85		27.2	119	10	5. VI	22. VII
	21. V. »	2 430	82		26.3	115	10	7. VI	22. VII
	27. V. »	2 400	80		26.1	109	10	9. VI	26. VII
Kytö a [1]	30. IV. 1953	2 020	100	2.4	34.0	118	9.8	20. V	1. VII
	7. V. »	1 725	85	2.8	33.5	113	10	22. V	1. VII
	15. V. »	1 625	80	3.1	32.4	111	10	28. V	5. VII
	22. V. »	1 655	82	2.9	27.8	109	10	5. VI	9. VII
Kytö b	30. IV. 1953	4 175	100	1.1	36.0	118	1.0	20. V	1. VII
	7. V. »	4 215	101	1.2	32.9	113	0.3	22. V	2. VII
	15. V. »	3 540	85	1.3	35.0	111	2.0	28. V	6. VII
	22. V. »	3 475	83	1.3	34.6	110	5.5	6. VI	10. VII
	29. V. »	2 845	68	1.5	31.1	108	4.5	8. VI	16. VII
Tammi	30. IV. 1953	3 860	100	1.2	35.2	114	0	20. V	1. VII
	7. V. »	3 485	90	1.3	35.6	109	0.3	22. V	2. VII
	15. V. »	3 270	85	1.5	37.2	108	1.8	28. V	6. VII
	22. V. »	2 980	77	1.5	37.3	108	4.8	6. VI	10. VII
Tammi	13. V. 1954	2 875	100		31.8	120	9.0	[2] —	—
	20. V. »	2 130	74		29.6	115	5.0	—	—
	28. V. »	2 000	70		30.1	111	5.0	—	—
Kytö	13. V. 1954	2 095	100		31.9	119	10	—	—
	20. V. »	1 930	93		30.0	115	7.0	—	—
	28. V. »	1 900	91		29.7	111	7.0	—	—
Sisu	13. V. 1954	2 495	100		34.0	127	9.0	—	—
	28. V. »	1 440	58		25.8	111	7.0	—	—
1st seeding		3 003	100		32.7	—	—	—	—
7—10 days after 1st seeding ...		2 631	88		30.9	—	—	—	—
15—20 » » » » ...		2 343	78		30.4	—	—	—	—

[1]) Without spring tilling; copper deficiency occurred.
[2]) Observations could not be made on account of insufficient staff.

Results of the error calculation. The significant error has been calculated for a 95 % limit of reliability.

Year	Test variety	Significant difference, kg/hectare	F value	m %
1951	Orion III oats	270	21.7***	3.1
1952	» »	580	1.8°	7.3
1952	Tammi oats	500	3.0*	6.2
1953	Kytö oats, test b	630	6.1**	5.6
1953	Tammi oats	505	5.5*	4.6
1954	» »	350	121.1**	4.8
1954	Kytö oats	235	39.1*	3.8
1954	Sisu oats	510	33.1°	6.5

Table 2. The results of the experiments relating to the time of seeding, performed with barley and spring wheat

Variety and time of seeding		Grain yield per hectare, kg	Grain yield per hectare, relative	Straw/grain yield ratio	1 000-grain weight, g	Growing time, days	Sprouting	Appearance of ears
Olli barley	11. V. 1951	3 390	100	0.9	—	111	1. VI	9. VII
	16. V. »	3 300	91	1.0	—	107	6. VI	13. VII
	21. V. »	3 500	103	1.1	—	103	9. VI	15. VII
	26. V. »	3 220	95	1.1	—	101	10. VI	16. VII
	31. V. »	2 690	79	1.2	—	97	12. VI	18. VII
Tammi barley	12. V. 1952	2 020	100	—	29.6	100	2. VI	10. VII
	17. V. »	1 900	94	—	29.8	95	3. VI	11. VII
	21. V. »	2 140	106	—	27.5	91	5. VI	12. VII
	27. V. »	1 810	90	—	26.9	85	11. VI	16. VII
	3. VI. »	1 750	87	—	26.8	78	11. VI	17. VII
Pirkka barley	2. V. 1953	1 760	100	1.1	40.3	109	19. V	28. VI
	9. V. »	1 930	110	0.8	41.6	104	22. V	1. VII
	16. V. »	1 855	105	1.1	42.1	97	27. V	2. VII
	23. V. »	1 920	109	0.6	39.0	96	5. VI	8. VII
	30. V. »	2 225	126	1.1	38.4	91	7. VI	10. VII
	6. VI. »	1 640	93	1.2	34.5	98	14. VI	14. VII
Tammi barley	2. V. 1953	1 920	100	0.8	33.5	97	19. V	25. VI
	9. V. »	2 075	108	0.8	34.1	94	22. V	27. VI
	16. V. »	2 000	104	0.9	35.2	93	27. V	30. VI
	23. V. »	2 270	118	0.7	35.9	91	5. VI	4. VII
	30. V. »	2 115	110	0.8	35.1	89	7. VI	8. VII
	1. sowing	2 273	100	—	34.5	—	—	—
	2. »	2 301	101	—	34.9	—	—	—
	3. »	2 344	103	—	34.9	—	—	
	4. »	2 266	99	—	—	—	—	
	5. »	2 195	96	—	—	—	—	
Apu wheat	9. V. 1951	3 000	100	1.8	—	132	2. VI	20. VII
	14. V. »	2 810	94	2.0	—	128	5. VI	23. VII
	19. V. »	2 570	83	2.1	—	125	9. VI	25. VII
	24. V. »	2 070	69	2.4	—	121	10. VI	27. VII
	29. V. »	1 660	55	3.0		116	12. VI	28. VII

Year	Test variety	Significant difference, kg/hectare	F value	m %
1951	Olli barley	83	105.6***	1.0
1952	Tammi barley	470	0.5°	6.8
1953	» »	285	1.6°	4.5
1953	Pirkka barley	380	1.7°	6.7
1951	Apu wheat	350	22.1***	4.8

Table 3. The results of the combined experiments in 1955, relating to time of sowing and time of cutting

Tammi barley, cut on	Grain yield, kg/hectare		Grain yield, relative		Straw yield, kg/hectare		Straw yield, relative		Strength of stalk		1 000-gr. w., g		Sprouting, %	
	seeded 29. V	seeded 6. VI	seeded 29. V	seeded 6. VI	29. V	6. VI	29. V	6. VI	29. V	6. VI	29. V	6. VI	29. V	6. VI
22. VIII	1 600	1 590	100	99	2 200	3 000	100	136	10	9	36.2	30.8	95	93
27. VIII	1 820	1 940	114	121	2 560	3 590	116	163	10	9	38.6	34.1	97	92
29. VIII	2 230	1 730	140	108	3 070	2 390	140	108	10	9	40.3	34.6	91	87
30. VIII	2 160	1 660	135	104	2 580	2 010	117	93	10	9	39.6	35.5	89	84
5. IX	2 320	1 500	145	94	2 500	1 800	114	82	10	9	40.6	35.7	83	80
23. IX	1 780	1 280	111	80	2 000	1 570	92	72	9.5	9	38.2	35.0	75	73
Eho barley,[1] cut on	24. V	2. V	24. V	2. V	24. V	2. V	24. V	2. V	24. V	2. V	24. V	2. V	24. V	2. V
22. IX	2 240	2 100	100	94	2 700	2 460	100	90	10	10	42.6	40.1	84	82
5. X	2 250	2 010	100	90	—	—	—	—	9	9	42.9	42.9	64	67

[1]) The test was located on mineral soil.

Table 4. Husk percentage in the experiments relating to the time of sowing, performed with oats in 1952

Variety	Time of seeding			
	21. V	17. V	12. V	27. V
Tammi	28.3	29.6	29.1	30.8
Orion III	32.7	33.2	32.9	33.7

on account of the late spring. The height of the crop from the first seeding (29. V) was 73 cm, and of that from the second seeding (6. VI) 83 cm.

It is seen from Table 1 that in 1953 a test relating to the time of sowing of oats was carried out on tilled as well as on untilled soil. In both instances the relative grain yield figures were similar. Considering furthermore that no detrimental periods of drought occurred at the Frost Research Station in the springtime in any one of the years concerned (Table 5), the conclusion appears to be justified that the test results cannot have been essentially affected by the fact that all the test plots were tilled at the same time, regardless of the time at which the seed was sown.

III. On the factors affecting the results of the tests

The correct interpretation of the results from any plant cultivation experiment requires, above all, knowledge of the degree of influence of such growth factors which may possibly constitute minimum factors. However, the basis of such an interpretation is strengthened in conformity with the accuracy with which the degree of influence of the various growth factors is known. This is of particular importance in a comparison between the results from different years or from different localities. Obviously, too, the study of the question under investigation profits from a more detailed analysis of the factors involved, if this can be achieved, as well as of the results of experiment.

A few of the most important factors connected with the question of the time of sowing will be discussed in the following.

1. *Weather conditions*

The weather conditions in the years concerned in these tests are described in Tables 5 and 6 and in Fig. 3 and 4. The temperature and rainfall of the growing season are given in pentads in Table 5; the effective temperature for each month is given in Table 6. The rainfall is also shown graphically in Fig. 3 and the effective temperature value (KERÄNEN 1951, p. 97) in Fig. 4.

In 1951 the mean temperature of June was lower than normal, and the rainfall was only 15 mm. The rainfall was normal in June and July. Au-

Table 6. The effective temperature value $T_t = \sum_{m=1}^{n} t_m$ —5°C for each month of the growing season at Pelsonsuo

Month	1951		1952		1953		1954		1955	
	T_t	Days >5°	T_t	Days >5°	T_t	Days >5°	T_t	Days >5°	T_t	Days >5°
V	18.8	13	52.8	15	98.9	24	166.9	24	30.5	13
VI	226.0	30	231.5	30	366.0	30	226.8	28	185.7	27
VII	282.4	31	301.1	31	312.3	31	374.8	31	330.9	31
VIII	345.1	31	199.7	31	276.9	31	271.9	31	338.4	31
IX	131.1	22	35.9	18	52.8	16	107.9	26	162.3	28
	1 003.4	127	821.0	125	1 054.1	132	1 148.3	140	1 047.8	130

Table 5. Weather conditions in pentads during the growing seasons of 1951—1955 at Pelsonsuo

Year	1951					1952					1953					1954					1955				
Month	V	VI	VII	VIII	IX	V	VI	VII	VIII	IX	V	VI	VII	VIII	IX	V	VI	VII	VIII	IX	V	VI	VII	VIII	IX
	Temperature, °C																								
Days																									
1—5	2.9	7.6	13.3	16.4	14.4	2.0	10.0	14.3	15.9	8.0	7.6	17.1	15.4	12.6	9.4	6.8	6.6	16.1	15.8	10.6	0.6	13.8	15.0	13.0	13.1
6—10	3.6	9.8	12.6	19.5	7.9	5.8	11.8	19.3	13.4	7.5	2.1	14.0	10.6	12.7	7.3	11.0	8.5	20.3	13.8	8.3	1.9	4.8	17.1	15.3	10.9
11—15	5.6	12.6	16.8	14.6	11.2	2.1	11.0	16.5	11.5	4.5	5.8	16.9	14.0	16.2	5.6	3.0	15.8	20.2	14.6	10.6	3.4	11.3	19.5	16.4	10.9
16—20	7.0	13.4	13.5	14.4	6.7	2.2	15.0	13.5	10.4	6.4	13.2	17.5	13.4	16.4	6.9	11.0	16.3	16.1	12.5	7.3	7.2	9.6	12.6	18.9	12.6
21—25	2.7	15.9	12.2	15.8	3.3	9.6	12.2	11.9	9.9	3.4	8.3	20.2	16.1	13.6	2.0	15.2	15.3	14.3	12.6	5.9	5.5	13.5	12.1	15.4	5.9
26—30 (31)	5.2	13.9	15.9	16.1	8.4	8.3	16.3	13.1	8.2	5.2	6.8	17.5	15.8	12.4	7.1	13.0	13.5	15.8	13.4	6.5	7.6	13.3	17.4	16.4	8.5
Mean for entire month	4.1	12.0	13.5	16.1	9.1	5.0	12.6	14.6	11.4	5.7	6.0	17.2	14.2	13.9	6.4	9.8	11.9	17.5	13.7	8.7	4.5	11.0	15.7	15.4	10.3
Normal	5.9	11.8	15.2	12.3	7.2	5.9	11.8	15.2	12.3	7.2	5.9	11.8	15.2	12.3	7.2	5.9	11.8	15.2	12.3	7.2	5.9	11.8	15.2	12.3	7.2
	Rainfall, mm																								
1—5	1.1	6.1	12.2	0.5	8.5	0.5	9.4	6.1	9.1	20.0	5.9	4.0	14.7	29.6	17.5	—	14.0	10.0	20.0	7.1	6	—	3	5	30
6—10	0.1	—	21.0	1.9	2.1	—	14.2	—	9.9	13.2	—	14.5	27.4	30.9	5.9	2.0	5.1	4.0	3.0	4.0	5	4	18	6	5
11—15	7.5	3.4	23.5	6.4	11.7	8.6	3.0	20.8	0.6	0.2	—	10.6	0.8	15.4	1.0	2.0	5.9	—	12.2	17.9	10	2	—	—	19
16—20	0.1	28.4	24.3	5.9	18.5	5.0	6.5	21.1	—	17.3	7.8	16.9	12.1	18.0	—	9.1	—	20.1	19.9	28.0	3	15	49	—	13
21—25	0.2	0.3	2.6	6.4	5.0	13.4	51.3	8.6	20.6	1.0	11.5	11.6	40.2	14.9	2.0	—	19.0	31.0	—	13.0	9	10	—	—	21
26—30 (31)	5.7	26.2	17.9	7.9	0.4	11.5	13.1	16.7	20.3	8.8	5.6	—	3.3	30.5	3.0	6.9	59.1	27.1	4.0	24.0	0	—	—	1	1
Total for entire month	14.7	64.4	101.5	29.0	46.2	39.0	97.5	73.3	60.5	60.5	30.8	57.6	98.5	139.3	29.4	20.0	103.1	92.2	59.1	94.0	33	31	70	12	89
Normal rainfall	42	61	71	77	62	42	61	71	77	62	42	61	71	77	32	42	61	71	77	62	42	61	71	77	62
Rainy days	—	—	—	—	—	11	8	14	13	14	14	15	17	22	9	6	20	20	11	22	11	10	8	5	18

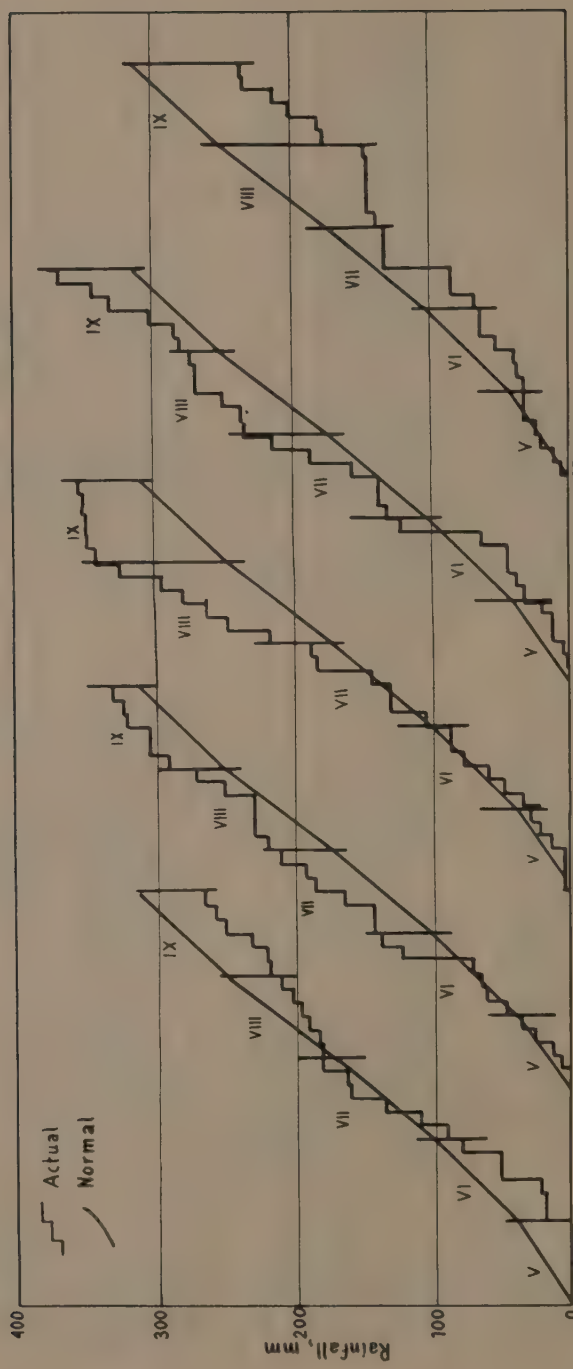


Fig. 3. Rainfall conditions during the growing seasons in 1951—1955 at Pelsonsuo.

gust was exceptionally warm, its mean temperature being 16.1°C (normal 12.3°C), but the rainfall was not more than about one third of normal. The warm weather persisted throughout September, the rainfall remaining below normal.

In 1952 the fields became free of snow on the last day of April. In consequence of the normal temperature which prevailed in May, the seeding could be commenced as early as on 12. V. The effective temperature value in May reached the value of 132°, mainly on account of the warm weather during the second half of the month. The abundant rainfall in June slowed down the growth which had come well under way, and the night frost which occurred in August, particularly that during the night between 15 and 16. VIII, had a disastrous effect. Apu spring wheat, for instance, did not form any grain at all. The effective temperature value of the entire growing period fell short of the corresponding figures for any other year by nearly 200°.

In 1953 the weather conditions of the summer were highly favourable. The rainy latter part of the summer caused some damage, but this was more than counteracted by the early spring (the snow covering disappeared on 16. IV) and by the temperature in June, which was higher than normal. The seeding could be commenced as early as 30. IV, and the effective temperature value in June was 366°, as against 232° of the preceding year. In consequence of the high humidity of the air during July and August, no night frosts occurred.

Table 7. The occurrence of night frost at Pelsonsuo toward the end of the growing season. Frost damage does not occur before below —3°C

Year				
1951	1952	1953	1954	1955
7. IX —2.3°	9. VIII —2.0°	5. IX —3.0°	8. IX —7.0°	29. VIII —3.0°
9. IX —3.5°	16. VIII —5.9°	6. IX —5.0°	9. IX —6.0°	30. VIII —3.5°
10. IX —3.5°	17. VIII —3.0°	14. IX —4.0°		24. IX —4.0°
11. IX —6.0°	18. VIII —3.5°			
	19. VIII —3.5°			

Table 8. The thawing of the frozen ground in 1951—1955 at Pelsonsuo

Year	Thawed ground, cm			Ground entirely thawed
	1. V	15. V	1. VI	
1951	8	20	—	28. V
1952	10	17	—	29. V
1953	14	18	37	3. VI
1954	7	16	35	7. VI
1955	0	4	20	13. VI

In 1954 the fields became free of snow on 24. IV. The mean temperature in May was 3°C higher than normal, and the seeding could be commenced on 13. V. This time, again, the excessive dryness of the latter part of May impeded the tillering. The rainfall in June was nearly twice the normal. Although the test areas could be cut in time, the final ripening and drying of the grain was hindered by the abundant rainfall in the autumn.

In 1955, after a winter with exceptionally heavy snow, the spring arrived late. The snow covering did not disappear before 15. V; tilling and the first seedings could not be commenced before the end of May or beginning of June. In spite of the late sowing, the crops ripened in time, with the exception of the late varieties. The rainfall of the entire growing season was nearly adequate inasmuch as no damage caused by drought was observed in the vegetation.

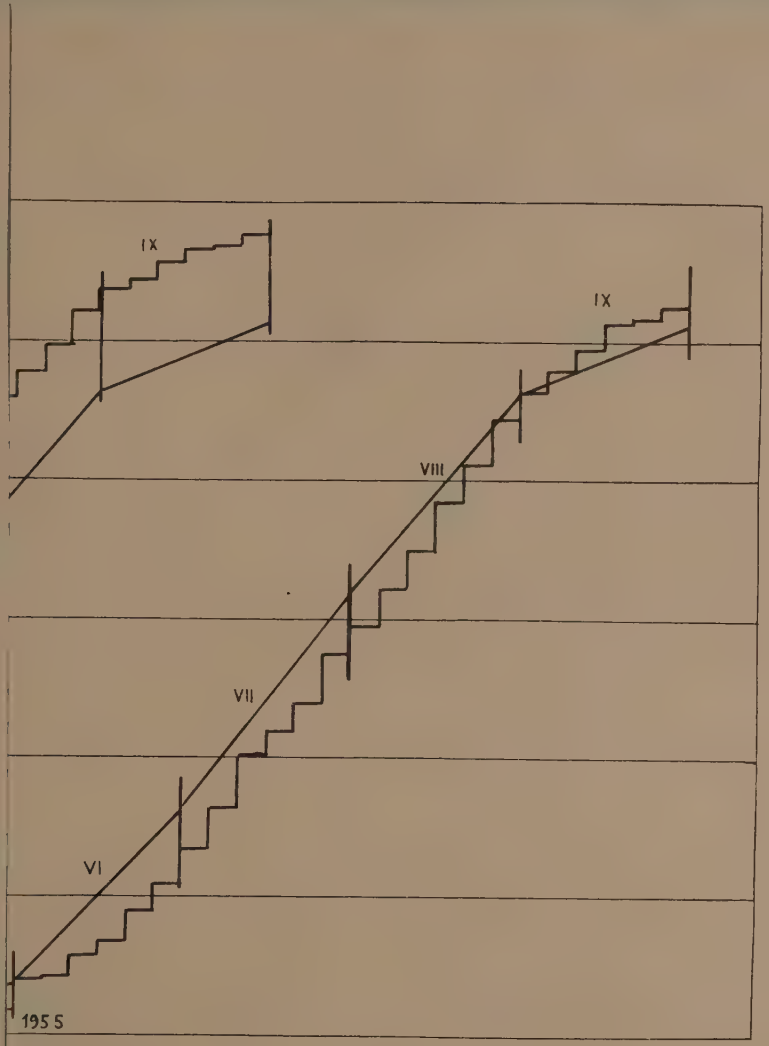
The night frosts which occurred toward the end of the growing season are shown in Table 7, and the thawing of the frozen soil is shown in Table 8. It is seen that 1952 was characterized by a very frequent occurrence of night frost; in the other years night frost did not occur before the first half of September. It should be noted, however, that frost injury did not appear in the plants before the temperature readings obtained with the method of measurement employed (Pessi 1954) dropped below —3°C. On comparing the dates of seeding with the dates when the ground thawed, it is seen that in nearly every case the sowing was done upon frozen ground.

2. *Radiant energy during the growing season*

The thermal and light radiation arriving from the sun is the key factor determining the development of plants as well as of any other living organisms. However, the amount of radiant energy arriving at the earth's surface is considered abundant to such a degree that even considerably greater crop yields than those obtained at present are possible merely from the viewpoint of the available radiant energy.

In addition to several local factors, the geographical location of the fields determines the amount of radiant energy which the soil will receive. However, in this respect, if the relative distribution of the arriving radiant energy over a certain period of time, for instance over the growing season, is considered, one common feature can be observed between the different regions. It is then found that the different months contribute to the total amount of received energy in approximately the same ratio (Lunelund, 1924, 1926, 1929, 1930, 1939, Ångström 1924, 1928). Table 9 shows the total thermal radiation in Stockholm in the years 1905—1926 (Ångström 1928, p. 21), at Ilmala, Helsinki, during 1916—1925 (Lunelund 1929, p. 25), and at Pelsonsuo during the two summers of 1954 and 1955. Furthermore, Table

Table 9. Total radiation, kcal/cm² in Stockholm in 1905—1926, according



d as normal.

tion of the monthly mean temperatures, however, the temperatures for all intermediate days were interpolated and the monthly means were computed from the temperatures for all the days in the month.

It is seen from these mean temperature values that, without exception, the soil temperature was lower in the early part of the growing season, as compared with the temperatures toward the end of the growing season.

4. *Soil temperature and germination*

When choosing the time for the sowing of spring cereals, there appears, among other problems, the question of the required soil temperature to be reached before favourable conditions exist for seeding. This point increases in importance with the shortening of the growing season, since a short growing season should not be unnecessarily further curtailed by the postponement of seeding.

It is held as a general rule that the soil temperature should be about +5°C before it is advisable to commence the sowing (Sauli 1947, p. 107). It has been found, however, that cereals germinate even at lower temperatures. For instance, Haberlandt already observed before the turn of the century that wheat, oats and barley form clearly discernible roots in 6—7 days at 4.7°C (1874, p. 107). At the Frost Research Station this question was studied by means of pot experiments.

The object of these investigations was to determine the temperature at which the germination of cereal seeds commences, as well as the degree of the detrimental effect upon the tillering resulting from keeping the seed at low temperatures for a prolonged time.

All the sprouting tests were made in three replicates. The pots were sheet metal vessels of 16 cm diameter and 9 cm height. The sand was moistened so that a sand ball pressed together in the hand split into 3—5 pieces when released. The vessels were filled with sand, which was compressed fairly tightly. The smoothed sand surface was exactly 3 cm below the rim of the vessel. 100 steeped grains were then spread on the sand in such a manner that they were not touching each other, and the vessel was filled with sand to the rim.

Three different tests were performed. In all tests the sprouting vessels of group I were placed in a low temperature for about one week. Each group contained all kinds of cereal. In the first two tests Group II, having the same seed items as Group I, was prepared about one week later than Group I and left to sprout at a higher temperature. At the same time the vessels of Group I were transferred into this same temperature. In the third test Group II was similarly prepared one week after Group I, but it was placed in the low temperature for one week together with Group I,

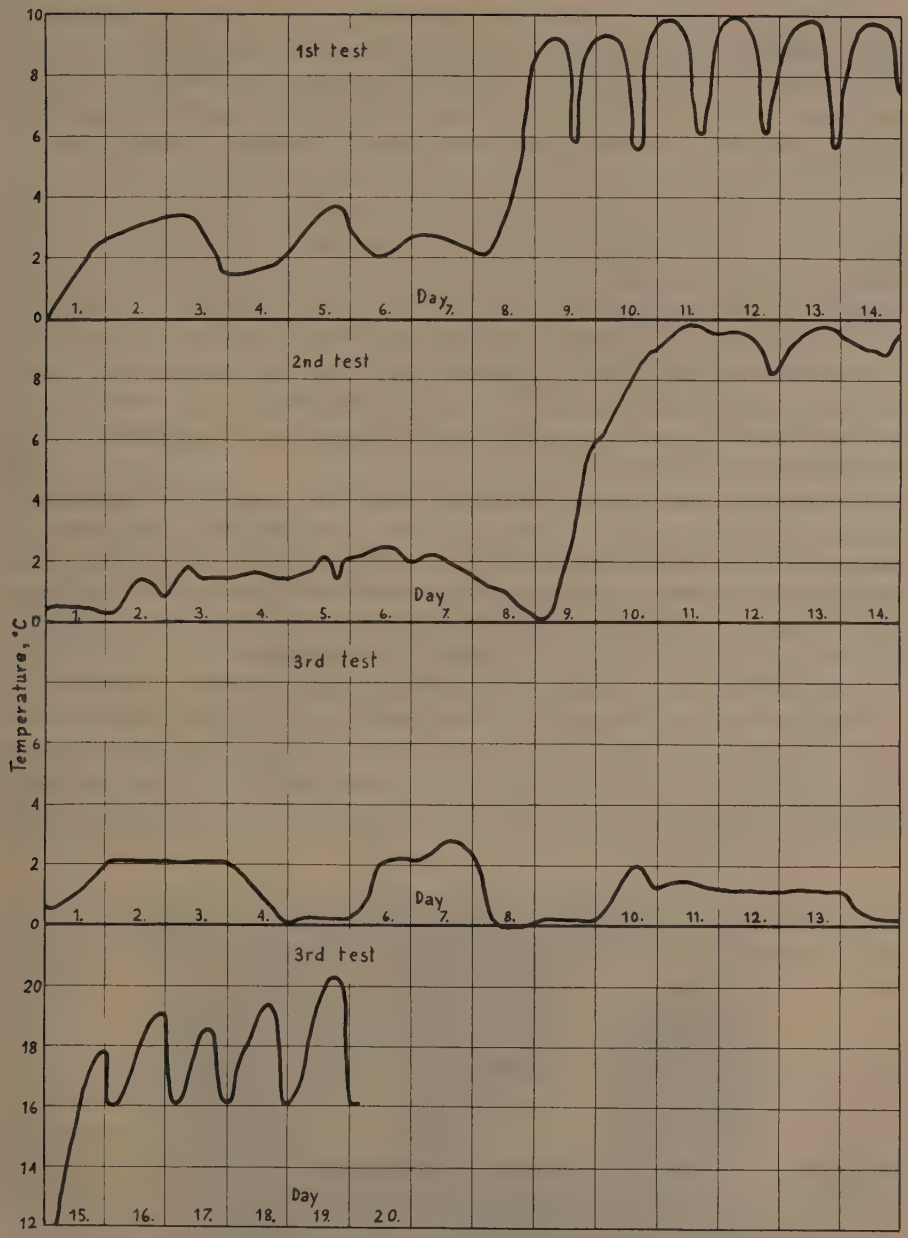


Fig. 5. Variation of temperature in the pot experiments.

which latter group thus received two weeks of low temperature treatment. After the second week, Group III was prepared and left to sprout at room temperature, into which Groups I and II were also transferred. After all the groups in each test had been transferred to the higher temperature, the appearance of the first shoots was noted. Thereafter observations of the state of sprouting were made at the same time every day.

The variation of the temperature in the vessels in all tests is seen from Fig. 5. In the first test the temperature was below +4°C during the first 8 days, i. e., this was the temperature for Group I until Group II was prepared on the 8th day and Group I was transferred to the same, higher temperature. From then onward the temperature varied between +6 and 10°C.

In the second test, Group I was kept for 8 days at a temperature which was below +2.2°C throughout this period. On the 9th day Group II was prepared for the experiment and put with Group I in a temperature which varied between +8 and 10°C.

In the third test, Group I was first kept for 7 days at a temperature continuously below +2.1°C. Group II was then prepared and placed in the same low temperature, together with Group I, for the next 7 days. During this time the temperature was below +2.0°C nearly all the time. After Group III had been prepared and placed in room temperature on the 15th day and the other two groups had been transferred to this same temperature, the temperature variation range was 16—20°C.

The percentages of sprouting during the course of the experiments are shown in Tables 12, 13 and 14. It is seen that, regardless of the species of cereal, Group I was always the first to develop shoots. In the third test, Group II sprouted after Group I, but before Group III. These observations

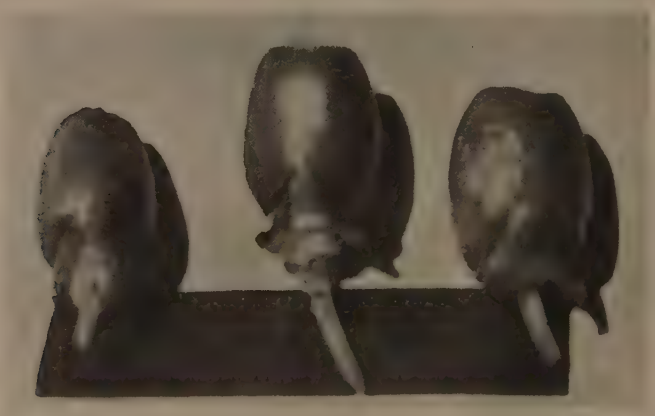


Fig. 6. Spring wheat grains after 3 weeks' germination at a temperature below +3.0°C.

Table 12. Sprouting percentages in the 1st test. Group I prepared on the 1st day, Group II on the 8th day. Group I has been kept at low temperature from the 1st to 8th day (Fig. 5)

Variety	Group	Sprouting, %										
		17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	At end of test
Pirkka barley	I	1±0	2±1	2±2	13±4	60±6	90±2	90±2	94±2	—	—	98±1
»	II	—	—	—	—	—	1±1	10±4	54±8	82±4	90±3	98±2
Balder barley	I	—	—	6±2	52±9	89±4	90±2	—	—	—	—	98±2
»	II	—	—	—	—	—	—	24±5	73±7	88±4	—	95±4
Orion III oats	I	—	—	—	—	2±1	16±8	43±11	56±5	70±3	—	79±2
» ...	II	—	—	—	—	—	—	—	—	3±1	40±8	76±3
Tammi oats	I	—	—	2±1	2±1	2±1	5±2	26±8	67±9	77±4	—	88±2
»	II									10±4	70±5	86±3
Kiuru spring wheat	I	—	—	—	—	4±2	25±11	38±9	49±8	62±5	71±4	75±2
»	II	—	—	—	—	—	—	12±4	36±8	56±7	64±5	74±2
Apu spring wheat ..	I	—	—	—	—	7±4	24±6	31±9	42±11	58±7	61±5	70±3
» ..	II	—	—	—	—	—	1±1	4±2	18±5	32±9	38±7	69±2
Koivikko autumn rye	I	—	1±0	21±5	48±11	61±9	69±7	72±5	84±2	—	—	84±2
»	II	—	—	—	—	—	30±8	56±8	64±8	77±4	—	87±1

Table 13. Sprouting percentages in the 2nd test. Group I prepared on the 1st day, Group II on the 9th day. Group I has been kept at low temperature from the 1st to 9th day (Fig. 5)

Variety	Group	Sprouting, %							
		20.	21.	22.	23.	24.	25.	26.	At end of test
Pirkka barley	I	5±4	19±10	50±11	87±5	95±1	—	—	97±1
»	II	—	—	1±1	28±9	60±12	88±3	94±2	97±2
Orion III oats	I	—	—	—	25±10	50±11	71±5	74±2	77±4
»	II	—	—	—	—	—	6±5	19±12	75±2
Kiuru spring wheat	I	—	—	1±0	10±3	17±3	33±5	59±5	70±3
»	II	—	—	—	1±0	4±2	28±4	45±2	72±2

Table 14. Sprouting percentages in the 3rd test. Group I prepared on the 1st day, Group II on the 7th day and Group III on the 15th day. Groups I and II have been kept at low temperature from the 1st to 15th day and from the 7th to 15th day respectively (Fig. 5)

Variety	Group	Sprouting, %							
		19.	20.	21.	22.	24.	26.	28.	At end of test
Pirkka barley	I	1±0	22±5	51±4	60±6	67±4	67±4	67±4	67±4
	II	—	6±3	34±4	42±6	59±3	64±4	64±4	64±4
	III	—	—	3±2	35±3	57±6	63±4	65±3	65±3
Tammi oats	I	1±0	21±4	48±5	53±4	55±4	57±4	59±4	60±3
	II	—	5±2	31±6	42±4	51±3	55±4	58±4	60±4
	III	—	—	10±3	35±6	44±5	52±5	60±4	61±4
Kiuru spring wheat ...	I	36±6	61±7	73±5	73±5	73±5	73±5	73±5	73±5
	II	1±2	38±6	58±5	67±6	77±3	77±3	77±3	77±3
	III	—	—	14±4	57±3	70±6	71±5	74±4	75±4

prove that all three kinds of cereals which were used in the tests have already been able to start germinating while kept at the low temperature imposed upon Group I at the start, and upon Groups I and II in the third test. In connection with the third test, direct observations were also made of this fact. Fig. 6 shows the roots developed by seeds during a period of two weeks at a low temperature.

Another interesting observation can be made from the last column of Tables 12—14. It is seen that the percentages of sprouting are not lower in the groups subjected to low temperature in the first phase of the test. Group I in the third test was kept below +2°C almost throughout the two weeks, and its temperature was even as low as near 0°C for a few days. Nevertheless, the figures relating to its percentage of sprouting are not lower than those in any other group. It can be concluded that low soil temperature at the beginning of the growing season does not harm the sprouting of the cereals or the later development of the plants; on the contrary, the shoots are able to utilize even this low temperature. This is also evident from the correlation between crop yields and soil temperature observed in 1952. Fig. 7 shows the variation of the maximum temperatures

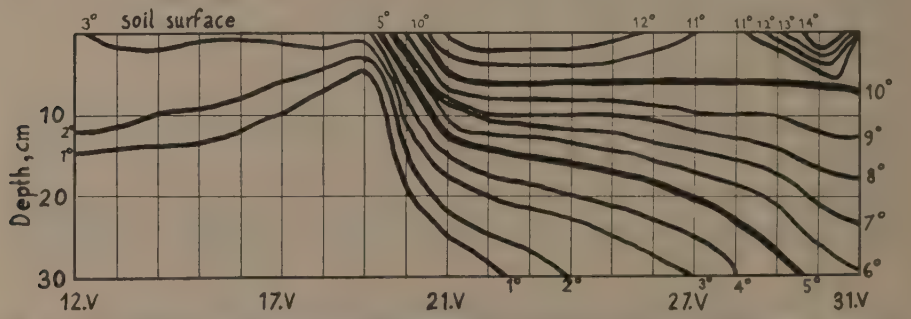


Fig. 7. The course of the soil isotherms between 12. V and 31. V. 1952 at Pelsonsuo. The isotherms represent the daily maximum temperatures.

in the soil from 12. V to the end of May, 1952. Between the first and second seeding the temperature at sowing depth did not once exceed +3.0°C. In spite of this, the first seeding of oats produced the highest grain yield (Table 1).

5. *The influence of night frost in the spring upon the crop yield of cereals*

The potential occurrence of night frost in the spring is generally considered only when choosing the time of seeding for barley. In the spring of 1951, night frosts occurred very frequently at the Frost Research Sta-

tion, and it is interesting to give closer attention to their influence in the experiments relating to the time of seeding.

The occurrences of night frost in the spring are tabulated in Table 15. The temperature measurements were performed with alcohol minimum thermometers provided with cylindrical radiation shields. This method of measurement renders values too low by 0.7—0.9°C, but in any case these values are higher by 0.6°C than those obtained without the radiation shield (PESSI 1954).

It is seen from Table 16 that all species of cereals had sprouted before the last severe night frost on 13. VI. The percentage of frost-damaged leaves on 16. VI is given in Table 17. It is seen that the frost damage to the shoots of oats and spring wheat was very insignificant and restricted to the earliest seedings, whereas the frost damage to the earliest seedings of barley was considerable. However, the damage varied with different seedings. In the shoots from late seedings only the tips of the leaves were injured. The shoots from early seedings also showed damage in the middle of the leaf blade, which gave a broken appearance to the leaves (Fig. 8). The frost damage to the first barley seeding was fairly extensive, nearly every other leaf being injured.

Table 15. Minimum air temperatures at top level of the shoots; spring 1951

Date	26. V	31. V	1. VI	4. VI	7. VI	8. VI	9. VI	13. VI
Minimum, C°	—4.2	—3.0	—4.6	—3.4	—2.9	—6.3	—5.6	—7.2

Table 16. Time of sprouting of spring cereals in the experiments relating to the time of sowing performed in 1951. The seeding time of barley differs from that of the other cereals (cf. Tables 1 and 2)

Cereal	1st seeding	2nd seeding	3rd seeding	4th seeding	5th seeding
Barley	1. VI	6. VI	9. VI	10. VI	12. VI
Oats	4. VI	7. VI	10. VI	12. VI	13. VI
Wheat	2. VI	5. VI	9. VI	10. VI	12. VI

Table 17. Percentage of frost-damaged leaves, 16. VI. 1951

Cereal	1st seeding	2nd seeding	3rd seeding	4th seeding	5th seeding
Barley	46 %	41 %	21 %	10 %	1 %
Oats	3 %	—	—	—	—
Wheat	6 %	2 %	0.5 %	—	—
Barley grain yield, kg per hectare	3.390	3.300	3.500	3.220	2.690

A similar study of the grain yields which have been presented before (Tables 1 and 2, Fig. 1 and 2), reveals that the grain yields in 1952 follow exactly the same course as the means of several years. Since no damage through the action of night frost in the spring occurred in any other year in the test relating to the time of seeding, and since the results of 1951 show no deviation whatsoever from those of the other years, it can be concluded that night frost in the spring causes no permanent damage to cereal plants. ANTTINEN (1954) has also arrived at the same conclusion.

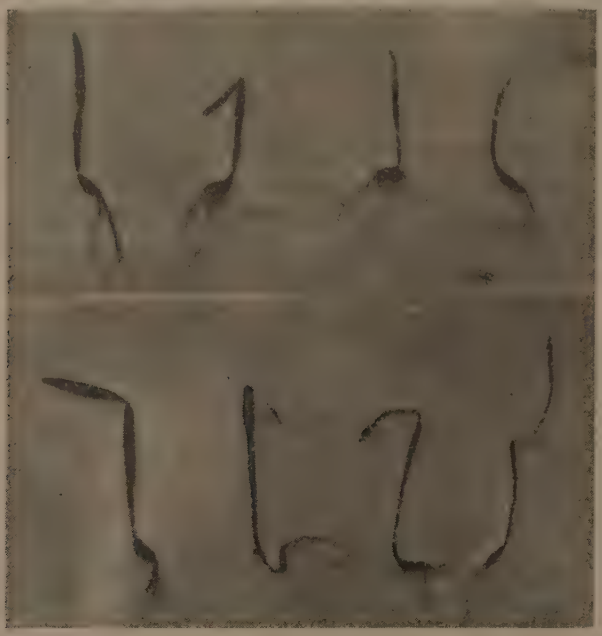


Fig. 8. Frost-damaged shoots of Tammi barley, spring 1951.

The effect of low temperature upon cereal seeds which have already started to germinate was also studied by means of a pot experiment. This experiment was performed in the winter, when sprouting vessels were put out of doors for 8 hours, in a temperature varying between —4 and —8°C. In each case the vessels were completely frozen when they were brought back into the room. Prior to this treatment, the spring wheat had developed roots of 1.5 cm length and a shoot of 2 mm, whereas the length of the roots was about 1 cm in the case of oats and barley, and the shoot tip had just previously split the seed coat. The freezing could not be found to have reduced the germinating power of any of the cereal species.

IV. Discussion of the results

The experiments relating to the time of sowing, which have been performed at the Frost Research Station and elsewhere, have shown that particularly in bog areas the best grain yield from oats and spring wheat is obtained when the seeding has been done at an early date. It can further be observed that this is true whether the weather conditions are favourable or unfavourable. The same applies to barley, although the tests at the Frost Research Station did not give similar results in all years. It can be noted, however, that the grain yield of crops from early seedings were, as a rule, not lower than those from late seedings. Consequently, and considering furthermore that in the case of occurrence of night frost in the autumn the early seedings produced the best barley crops (1952), it is also advisable even in the case of barley to perform the sowing as soon as possible after the other seeding operations. In the conditions prevailing at the Frost Research Station the sowing of barley, too, should not be left later than the 20th of May, if it is at all possible to do the sowing before this date. In practice, however, the sowing of barley under comparable conditions is still being done, probably to a quite considerable extent, in June.

One of the likely reasons for this prevailing practice may be a fear that the cold soil is not advantageous to the development of the barley plants and that the shoots might be permanently damaged by potential night frost in the spring. According to the investigations at the Frost Research Station, however, no such damage is caused to any spring cereal, and similar experiences have been reported from the Plant Cultivation Research Station of Northern Ostrobothnia. The pot experiments carried out at the Frost Research Station, as vell as the soil temperature measurements in connection with the field tests, give further proof that *low soil temperature at the time of germination is not detrimental to the sprouting, nor to the later development of the cereal plants.* Thus it is obvious that the soil temperature does not constitute a restricting factor when the time of sowing is being chosen and when it is required to perform the seeding operations at the earliest possible time. Instead, this time is essentially determined by the moisture condition of the soil. The seeding can be done as soon as the soil moisture permits. The general saying that barley must not be sown on cold and wet soil combines two different circumstances which are difficult

to keep apart in practice. Nevertheless, this saying is incorrect. It should be: barley must not be sown on wet soil. The question of the weeds, too, has a certain connection with the choice of the time of sowing, since the farmers mention as one of the disadvantages of early seeding the fact that weeds germinate more quickly at low temperatures than the seeds of cereal plants do.

It was made evident in the introduction that the frost damage to spring cereals in Finland might be reduced if the ripening of the grain could be advanced to an earlier date. One of the ways of achieving this is to perform the seeding at the earliest possible date; this should be attempted in all cases for the additional reason that, as a rule, early seeding gives the best grain yield, regardless of the year's weather conditions. Although it is possible to influence the thermal conditions in the soil to some extent, it can be said that with regard to the question of the seeding time, it is fortunate that the thermal conditions in the soil do not form the decisive factor, which is rather comprised by the moisture conditions and occurrence of weeds in the soil. These are circumstances which can be quite remarkably influenced by means of expedients of agricultural practice, as is readily realized if one considers the condition of cultivated fields particularly in the localities where the greatest extent of frost damage occurs.

It can be mentioned as a further advantage of early sowing that the stalk will be stronger than that from later seedings. Also, the damage caused by destructive insects, usually the frit fly *(Oscinis frit* L.) is less in the crops from early seedings (Saalas 1954, p. 92, Salonen 1955).

Modern mechanization of agriculture enables the farmers to get the spring tilling and seeding operations done very quickly, once it has been possible to commence them. However, this mechanization has a serious drawback which particularly concerns cultivated bog areas where the seeding should expressly start at an early time. When tractors are employed, it is quite often impossible to commence the tilling of such areas as early as when horse-drawn equipment is used.

The question as to why, in the case of oats for instance, early seeding without exception produces the highest grain yields, is of interest in itself. The connection is readily understood in the cases when night frost occurs in the autumn, but its cause is more difficult to point out without closer investigation if no damage results from the autumn night frosts, even to crops from the late seedings. This question will be discussed in the following.

The factors to which attention will be paid in the following are: the thermal conditions of the air, the thermal and moisture conditions in the soil, radiation energy, and injurious insects. It is of interest to study the action of these factors at the beginning and at the end of the growing sea-

son. The intermediate time presents the same conditions of growth for all plants, regardless of the time when they were sown.

As an instance of a year without damage caused by night frost in the autumn, we can consider the year 1953. The first seedings of 1951 can be studied from this point of view, too.

Table 6 shows the thermal conditions in the air in pentads. It is seen that the air temperature was lower at the beginning of the growing season than at the end, for which reason the late seedings could grow under more favourable circumstances in this respect. The thermal conditions in the air cannot thus be responsible for the superiority of the crops from the first seedings.

The thermal conditions in the soil are given in Table 11, and it is seen that the soil temperature was considerably higher at the end of the growing season than at the beginning.

No experimental data exist on the moisture conditions in the soil, but it is very unlikely that these would have contributed essentially to the differences in grain yield. No detrimental effects from drought were observed, and as can be seen from Table 5 and Fig. 3, rain occurred at fairly regular intervals in the springtime.

Radiation measurements are only available from the years 1954 and 1955. However, as is borne out by their results, as well as by all the other radiation measurements (Table 9), it can be stated as a quite general rule that considerably greater amounts of radiant energy arrive on the earth's surface in the early part of the summer than in September, even. It follows that the crops from early seedings receive more radiant energy than those which have been sown at a later date. Although no data concerning the distribution of radiation in the range of optical wavelengths over the growing season can be presented in this connection, it is highly probable that this closely follows the distribution of the thermal radiation.

Among the injurious insects, the frit fly *(Oscinis frit* L.) constitutes a noteworthy influencing factor. It is reported as a general observation that the damage caused by this fly is least in the crops from early seedings (Saalas 1943, p. 292). However, it is not likely that this might alone furnish the decisive factor determining the superiority in regard to grain yield of the early seedings, since in 1953, for instance, the frit fly only occurred in quite an insignificant degree at the Research Station (cf. Vappula 1953). Anttinen has similarly stated as his opinion (in a talk with the author) that the frit fly cannot be thought to be of decisive influence in this respect.

In the light of this discussion, the cause of the superior grain yield obtained by early sowing may be found in the abundance of solar irradiation in the early part of the summer. According to investigations performed (Valmari 1930), however, the radiant energy cannot constitute a restrict-

ing factor in the conditions prevailing in Finland; on the contrary it should be sufficient for even greater crop yields per hectare than those obtained at present. It is possible, however, that the amount of radiation may have a different effect upon the development of the reproductive and of the vegetative parts of a plant. This would be consistent with the observation (cf. Table 1) that the straw yield frequently becomes greater in comparison with the grain yield in the crops from later seedings than in those which have been sown early in the spring. With this is associated also the question of the length of the day. Our cereal plants are plants favouring a long day (Pohjakallio and Salonen 1947), and greater duration of daylight has been found to accelerate particularly the commencement of flowering (Pohjakallio 1953). However, no investigations exist which would reveal whether this also has an influence upon the yield. It should be considered that the said stage of development of the plants will thus occur at a time of greater daylight duration in the case of the crops from early seedings.

One possible reason may also be the fact that the temperature during the time of germination affects the later development of the plant, inasmuch as a low temperature during germination favours the development of the reproductive parts, whereas a higher temperature would similarly further the development of the vegetative parts. In connection with this hypothesis, is the jarovisation of cereals, which is important also with regard to the spring cereals, according to the experiments of Lysenko (1951).

Conclusions

The present work deals with experiments relating to the time of sowing of spring cereals. The investigations were carried out at the Frost Research Station (long. = 26.5°E; lat. = 64.3°N) during the years 1951—1955. Moreover, some factors affecting the results of the tests have been studied. The most essential results of this investigation are:

1. In experiments relating to the time of sowing, performed in such a way that the first seeding was done as soon as possible, the grain yield obtained from oats and spring wheat was better in regard to quality as well as to quantity in accordance with how early the seeding was done.

2. The grain yield obtained with barley in the tests relating to the time of sowing was fairly uniform on an average. However, even the crops from early seedings did not suffer from any untoward effects. Since in summers of unfavourable thermal conditions the best crop yield was obtained from the early seedings in the case of barley, too, it is advisable to perform even the seeding of barley as early as convenient.

3. With all spring cereals the straw yield/grain yield ratio was found to increase consistently with the postponement of the seeding operation.

4. The length of the stalk was greatest and its resistance against falling flat least, on an average, in the crops from the late seedings.

5. The night frosts in the spring have not been found to cause permanent damage to any of the spring cereals.

6. Low soil temperature has not been found to have detrimental effects upon germination, sprouting or later development of any cereal. It is thus not the soil temperature, but merely the moisture content of the soil, that determines the time when the sowing can be commenced in the spring.

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Selostus:

Kevätviljojen kylvöajan vaikutuksesta satoon

Yrjö Pessi

Hallakoeasema, Pelsonsuo

Tutkimuksessa selostetaan Hallakoeasemalla Pelsonsuolla suoritettuja kevätviljojen kylvöaikakokeita. Kokeet on suoritettu vuosina 1951—1955 suoviljelyksillä. Ne on järjestetty siten, että ensimmäinen kylvö on suoritettu heti, kun se on ollut mahdollista suorittaa, sekä muut kylvöt tämän jälkeen 5—7 päivän väliajoin. Lisäksi tutkimuksessa käsitellään koetuloksiin vaikuttavia tekijöitä.

Tärkeimmät tutkimustulokset käytännön kannalta ovat seuraavat:

1. Kun kevätviljojen kylvöaikakokeita on järjestetty siten, että ensimmäinen kylvö on suoritettu heti, kun se on ollut mahdollista, ovat kaura ja kevätvehnä antaneet sekä laadullisesti että määrällisesti sitä paremman jyväsadon, mitä aikaisemmin kylvö on suoritettu.

2. Ohran kylvöaikakokeiden jyväsadot ovat olleet keskimäärin melko tasaisia. Mitkään seikat eivät ole haitanneet kuitenkaan aikaisiakaan ohrakylvöjä. Kun lämpöoloiltaan epäedullisina kesinä myös aikaiset ohrakylvöt antavat parhaat sadot, olisi ohran kylvökin syytä suorittaa mahdollisimman ajoissa.

3. Olkisadon suhde jyväsatoon on muodostunut kaikilla kevätviljoilla sitä suuremmaksi, mitä myöhäisemmin kylvö on suoritettu.

4. Korren pituus on ollut suurin ja laonkestävyys keskimäärin heikoin myöhäisissä kylvöissä.

5. Keväthallojen ei ole todettu aiheuttavan pysyviä vaurioita yhdellekään kevätviljalle.

6. Maan alhaisella lämpötilalla ei ole todettu olevan haitallisia vaikutuksia minkään viljan itämiselle, orastumiselle tai myöhäisemmälle kehitykselle. Maan lämpötila ei määräisi näin ollen sitä, milloin kevätkylvöt voidaan aloittaa, vaan maan kosteus.